

ANNEX 'A'

LOW FLYING INSTRUCTIONAL GUIDE

Strike Squadron Exercise No 23 Reconnaissance Squadron Exercise No 32

- References A – MoD Flying Orders 102, 311 to 315 incl
B – No 3 Group Air Staff Instructions, Section 3, Order 7
C – MoD Flying Orders No 119
D – MATO Low Flying Handbook
E - No 3 Group Air Staff Instructions, Section 3, Order 18

Introduction

1. Low flying is defined as flying sufficiently close to the ground to give a true impression of speed.
2. The present role of the Canberra Force requires a considerable amount of low flying and it is therefore imperative that all crew are thoroughly versed in the basic aspects of operating at low level.
3. Although modern aids and reliability of equipment make it unlikely there is nevertheless still the possibility of having to fly low because of bad weather. This aspect is covered briefly.

Regulations

4. The regulations pertaining to low flying may be studied in references A and B and are therefore not repeated here. Suffice it to say that all low flying must be properly authorised and the appropriate low flying areas and routes booked at 'Operations'.

Public Relations

5. Although low flying practice is essential and special areas and routes are set aside for training it is good manners and common sense to avoid disturbing the local population, both human and animal, as far as possible. Reference C should also be studied.

Pre-Flight Map Study

6. As high speed low flying demands absolute concentration from all crew members the area and route must be thoroughly studied before getting airborne. Such things as landmarks, towns, hazards, prohibited and danger areas should be memorized so that a brief look at the map is sufficient reminder whilst airborne. See reference D.
7. Although student navigators are instructed in map study during their ground school phase, it is the responsibility of the QFI to ensure that before the student crew fly on a low level exercise they know what to study on the map. It is worth bearing in mind that that most student will have little experience of low level map reading, especially at high speed.

Fuel

8. The fuel consumption of the Canberra at low level is 62 lb/min without tip tanks and 72 lb/min with tip tanks flying at 250 knots. This gives, in the T4, an endurance of little over 90 minutes if the aircraft is to be overhead base with 4000lb of fuel.
9. From the foregoing it is obvious that the student crew must become fuel conscious and that checks on the fuel state must be made at regular and frequent intervals.

Height

10. The height at which a particular sortie will be flown will depend on the weather, terrain, operational necessity and crew proficiency. At the OCU the minimum heights are laid down in current orders and may be varied from time to time. However the dual exercise should be flown at 250 feet AGL if possible to obtain maximum benefit.
11. Because of its errors the pressure altimeter cannot always be relied upon. Therefore in the absence a radio or radar altimeter the pilot must maintain the correct height Above Ground Level by use of his own judgement, which can be perfected only by experience. Before descending to low level Regional QNH must be set on all altimeters.

Effect of Wind

12. Movement over the ground is more apparent when low flying than at more normal altitudes. When flying at low speed upwind or downwind the decrease or increase in ground speed may be noticeable but at the normal operating speeds of the Canberra the effect will be negligible.
13. Turns made near the ground will also be affected by the wind and, in particular, turns into wind from downwind will have a larger effective radius than would normally be expected. This must be allowed for when turning to avoid an obstacle.

Turning Performance

14. It is only when low flying that the size of the turning circle becomes evident and, because of the need to avoid obstacles, of real importance. As a rule of thumb it can be said that in a rate 1 turn the radius of the turning circle in miles is approximately equal to one third of the TAS in miles per minute. For example, at 240 knots or 4 miles per minute, the radius is one and one third miles.
15. Minimum Radius Turns – Consider a hypothetical ‘ideal’ aircraft, that is one without ‘g’ or structural limitations, or compressibility effects and with a very high thrust weight ratio. To achieve a minimum radius turn a combination of the following is required:
 - a. Maximum angle of bank
 - b. Maximum angle of attack (i.e. at the verge of the buffet)
 - c. Maximum IAS obtainable
 - d. Maximum thrust.

Because the Canberra is by no means ‘ideal’ the conditions for minimum radius have to be modified to:

- a. Maximum angle of bank consistent with b, c and d below
- b. Maximum loading with maximum angle of attack (i.e. 4g at the verge of the buffet)
- c. An IAS that will enable 4g to be held at the verge of the buffet
- d. Sufficient thrust to maintain c in a level turn. This may be full throttle.

Theory states that the manoeuvre stalling speed (V_{sm}) is a function of basic stalling speed (V_s) and load factor (LF). The equation is $V_{sm} = V_s \times LF$. For a Canberra at 32,500lb AUW $V_s = 85$ kts. Therefore for a turn at maximum loading, $V_{sm} = 85 \times 4^2 = 170$ kts. In practice however, it is found that a higher speed is required to hold 4g on the verge of the buffet and in the T4 it is in the range of 180 to 200 kts, depending on AUW. This is because the aircraft is held at the verge of the buffet and not stalled.

16. Turning to Avoid an Obstacle – When turning to avoid an obstacle the main consideration is the distance travelled while the turn is being initiated rather than the radius of the turn that is eventually established. This distance depends on the speed because of the inertia problem and the length of time required to roll on bank. Because of the adverse yaw produced when aileron is used, and the aileron control system, judicious use of rudder will greatly facilitate entry into turns. When the need arises to turn quickly whilst flying at high speed the following technique is recommended. Close the throttles and open the airbrakes, start applying bank using rudder to assist aileron and as the speed approaches the optimum (180 – 200 kts) close the airbrakes, increase RPM to maximum and loading to 4g, whilst maintaining maximum angle of bank. The restriction of not more than 2g with aileron applied must be observed.

Turbulence

17. Low flying in conditions of moderate or severe turbulence should be avoided as the fatigue life of the aircraft will be drastically reduced and the crew will tire quickly. When operational circumstances demands low flying under these circumstances, if at all possible, fly at the appropriate turbulence speed as given in Pilots' Notes.

Flying over the Sea

18. Flying low over the sea presents two problems that are not encountered over land, namely: height judgement can be difficult especially over a glassy calm and salt spray from a rough sea may cover the canopy and impair visibility from the cockpit. For obvious reasons it may be advisable to fly a little higher than normal when the above conditions exist. On relatively frequent occasions there may be no definite horizon and extra care must be taken especially when turning.

Flying over Sand

19. The two main problems associated with low flying in sandy regions are firstly, the possibility of rising sand which will drastically reduce visibility and secondly, lack of relief makes it possible to approach rising ground without appreciating it. In particularly featureless areas it is inadvisable to fly below 250 feet AGL not only because of these problems, but because it is possible to become hypnotised and get much closer to the ground than one realises.

Flying over Snow

20. Flying low over snow is similar in many respects to flying low over sea or sand. Lack of relief and a changed terrain after fresh snow must be allowed for. Many landmarks may be obliterated or completely changed in appearance and in certain conditions the snow covered ground and the sky may merge into a single white surface known as a 'white out'. If faced with these conditions and the exact whereabouts of the ground is in doubt the aircraft must be climbed away on instruments. Reference E should also be studied.

Radio Aids

21. Radio reception is adversely affected by low altitude and the higher the frequency the more it is affected. Thus if radio reception or transmission is vital the aircraft may have to be climbed to get the necessary range from the radio equipment.

Lookout

22. It is stating the obvious to say that a sharp lookout is very important when low flying. Nevertheless it must still be said. In order that the minimum time is spent looking inside the cockpit while at low level a careful check should be made before descending. Special attention must be paid to such things as fuel state, stowage of loose articles and ensuring that harness is tight.

Birds

23. The hazard of bird strikes is well known but no method of avoiding them has yet been found. However avoiding areas where birds are known to congregate and the times when they leave from and return to nesting or roosting sites, i.e. dawn and dusk, will reduce the chances of a bird strike. Similarly flying in certain areas during the migratory seasons, which are notified by NOTAM, should be avoided whenever possible. If following other aircraft along a route one should expect to encounter more bird activity, as the leading aircraft will have disturbed the bird population.
24. By the time a bird is seen to be in the flight path of the aircraft it is usually too late to take effective avoiding action. Turning is out of the question in the time available and descending is obviously dangerous. This leaves climbing which may be useful especially as birds usually break downwards when a collision is imminent.

Low Level Map Reading

25. A comprehensive précis on low level technique is issued to navigators during the ground school phase and they have some five lectures on the subject. However, as this is their first opportunity to put theory into practice it is important that the QFI discusses with the whole crew the methods of map reading as a crew.
26. Because the navigator cannot see outside from the back of a T4 he should be encouraged to use the 'commentary' system, where he map reads and the pilot looks for the features. This system can be adapted for use in the B2/PR3 Where both pilot and navigator can see out, but where it is impractical for the pilot to hold a map and fly the aircraft. Nevertheless, the pilot should carry the appropriate maps with him.
27. The system used on the squadron will depend on the mark of the aircraft and whether the crew has one or two navigators. Therefore crews must be prepared to be adaptable when they leave the OCU.

Bad Weather Low Flying

28. If forced to fly low because of poor weather conditions speed should be reduced to 170 kts and the flaps kept up. This gives best endurance and good manoeuvrability.

Weather Deterioration

29. If the exercise has to be discontinued because of bad weather climb to at least the minimum safe flight level and return to base. NB: If flying under controlled airspace when the sortie is abandoned the appropriate rules must be observed and control obtained as soon as possible from the appropriate authority.

Procedure When Uncertain of Position

30. If at any time the navigator becomes uncertain of his position climb to 3000 feet AMSL or to the nearest quadrantal above safety height. If an accurate position using all available aids can be determined within ten minutes a descent may be made to continue low level; otherwise return to base.

LOW FLYING AIR EXERCISE

SEQUENCE

1. Book area and route at Operations.

2. Study the route with the whole crew.

3. Fly to the appropriate low flying area and let down.

4. Descend to 250 ft AGL (this can be done in stages, levelling off at 1000ft and 500ft initially if the instructor wishes).

5. Starting at a convenient point fly round the low level route. Assist with map reading as required.

OBSERVATIONS

- a. Ensure the student understands the method of booking, the significance of his clearance number and the importance of estimating his entry time accurately.

- a. Point out the likely hazards including:
 1. High ground
 2. Pylons and TV masts
 3. Airfields
 4. Known areas of bird activity

- b. Point out the features that are most likely to be of use at low level, noting particularly which can be used for timing and which for track checks.

- a. If weather permits fly between 2000 and 3000ft on Regional QNH and map read to the low flying area.

- b. If weather is unsuitable for 3a fly to a convenient airfield and descend under their control, remembering that this will need arranging before the flight.

- c. Before descending below 2000ft:
 1. Check position and that Regional QNH has been set.
 2. Select fuel pumps as required and check fuel contents.
 3. Ensure harness is tight and that loose articles are stowed.
 4. Check compasses.
 5. Inform controlling authority of entry time into low flying area.

- d. Descend in a turn keeping a good lookout on both sides
 - a. Height is estimated by reference to ground features.
 - b. Compare radii of turns at 30° and 45°. (NB 30° gives a radius of approximately $1\frac{3}{4}$ miles, which is the radius used by navigators for planning a low level sortie).

- a. Accurate headings and speeds are most important.

- b. Absolute reliance must be put on the navigators timing if a turning point is not found.

- c. If seemingly off track make no attempt to regain it until a second observation confirms the fact, then alter heading to regain track at the next check point, or, if a well defined feature known to be on track can be seen far enough ahead 'S' turn to fly over it.
- d. The navigator reminds the pilot of what to look for at the next turning point early during each leg.
- e. Fuel must be checked after each turning point but not during the turn when "eyes must be outside the cockpit".
- f. Before turning set the new heading on the G4B.
- g. After turning carry out a compass check.
- h. Turns are made with 30° to 40° of bank, the aim being to keep on track by using the correct (1³/₄ miles) radius of turn.

6. Pick an easily discernable ground feature and fly over it at 250' and 150, 250 and 350kts in turn, each time starting a turn of 60° of bank as the aircraft passes over the ground feature.

- a. At 150kts the aircraft is easily turned and has a small radius of turn. The time and effort needed to apply bank is small.
- b. At 250kts bank is more difficult and takes longer to apply, and the radius of turn is increased. However the aircraft can still be flown with one hand.
- c. At 350kts bank takes a considerable time and effort to apply and the radius of turn is very much increased. The aircraft now needs to be flown with both hands on the control column.
- d. The LABS modified aircraft is lighter on the elevator and aileron controls than the unmodified version.

7. Allow the student to reduce speed to 170kts.

- a. This is endurance speed. The aircraft is also very manoeuvrable so 170kts is the speed recommended for bad weather low flying.

8. Demonstrate and let the student practice a minimum radius turn.

- a. Maximum angle of bank is required (about 85°)
- b. Full power is required once bank is applied.
- c. The aircraft is flown just on the buffet with 4g registered on the accelerometer.
- d. Not more than 2g must be applied while large amounts of aileron are being applied.

- e. Speed increases to and stabilises at around 180 to 200 kts.
- f. A little rudder may be used to assist entry.
- g. If the aircraft is not held on the verge of the buffet it will accelerate above minimum radius speed and it is impossible to regain the minimum radius turn without first decelerating or overstressing the aircraft.
- h. Note the ability to “turn on a sixpence”.
- i. If the turn is entered at a higher speed it is possible to overstress the aircraft and so great care must be taken.

9. Allow the student to practice entering a minimum radius turn at a high speed, say 300kts.

- a. Close the throttles and extend the airbrakes.
- b. Enter the turn as in sequence 8, taking care not to exceed 4g and closing the airbrakes and applying full power as the speed approaches the optimum for a minimum radius turn.
- c. Rudder will greatly reduce the time taken to initiate the turn.

10. Set heading for base and while still at low level throttle back an engine simulating a bird strike, fire or mechanical failure.

- a. The aircraft should be climbed using not more than $1\frac{1}{2}$ g so that 1000ft is reached as quickly as possible consistent with the navigator being able to get back to his seat.
- b. Speed should not be allowed to decrease below the minimum recommended for hatch jettison, i.e. 150kts.
- c. If simulating a bird strike carry out a low speed handling check at a safe height by lowering the undercarriage and flaps and reducing speed to threshold speed or the speed at which control becomes difficult, whichever is the higher. Note: the speed found above plus 5 – 10 kts, should be the minimum used on the approach after an actual bird strike.

11. Return to base.

- a. Let the student rejoin by one of the standard methods according to the weather conditions and his training requirements.

DBH February 1966

